Environmental Health Perspectives
Vol. 9, pp. 129–132, 1974

Asbestos in Talc

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Talc deposits include asbestos minerals such as chrysotile and amphiboles that may be carried over into consumer products. Optical microscopy and x-ray diffraction analyses may not reveal their presence. Examples are given of electron microscopy procedures that permit detection and measurement.

The mineral talc is a hydrous magnesium sheet silicate that occurs in both platy and fibrous crystal forms. Talc tends to occur in rock masses coexisting with a number of other hydrous magnesium silicate minerals. Typically, talc deposits consists of fine-grained, intergrown mixtures of minerals which may contain considerable amounts of asbestos. In addition, talc deposits often show complex mineral zonation, which adds to the difficulty of selective mining. For example, in the talc deposits of the Gouveneur District of New York State, talc occurs with the asbestos minerals chrysotile, tremolite, and anthophyllite in addition to other silicate minerals.

Since the mining of talc rock almost invariably includes the mining of asbestos as well, the asbestos contaminant may be carried over into the consumer product and thus introduce the risk of asbestos disease. This possibility leads to an important public health question: is asbestos present in consumer talcs, and if present, which mineral fibers and in what concentrations?

Among the standard mineralogical techniques which may be used for identification and quantitation of asbestos in talc are optical microscopy, x-ray diffraction, and electron microscopy (EM).

Optical microscopy, employing polarized light optics, is useful for determining the optical properties of particles. However, in the instance of talc, the extremely fine grained intergrowths of different minerals and the extensive overlapping and similarities of their optical properities limit this technique to a preliminary or screening function. Since large numbers of fibers may go undetected, optical microscopy would not be capable of quantitative analysis.

X-ray powder diffraction is a routine technique for analyzing crystalline materials. It is relatively simple in principle, but the results may be difficult to interpret. The limitations of precision and accuracy must be given careful consideration.

The identification and quantitation of asbestos fibers in talc by x-ray diffraction may be achieved by comparison of known dilutions (fiber type and quantity) of asbestos in a talc matrix with unknowns. The preparation of standard dilutions of asbestos minerals in talc for quantitative analysis requires: (1) a talc matrix completely free of contaminating asbestos minerals, (2) pure asbestos fiber as the sought adventitious phase, (3) a preparation method for insuring homogeneity and reproducibility of the standard dilution material, and (4) selection of x-ray reflections with no superimposed interferences. Condition (1) requires the selection of pure talc matrix material. In the first stage of screening, material was first scanned by x-ray diffraction to identify the major mineral phases rapidly, especially asbestos minerals. If no asbestos phases were detected, the material was

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re-examined in a more sensitive mode of x-ray diffraction called step scanning, and finally by electron microscopy. In this way a pure talc was selected (pure with respect to asbestos; small amounts of chlorite and phlogopite mica were tolerated).

In a similar way, pure samples of anthophyllite, tremolite, and chrysotile were screened and selected for use in preparing the talc-asbestos standard dilutions.

In x-ray diffraction the reproducibility of reflection intensities is strongly influenced by the degree of cleavage of crystalline powders. The minerals under investigation exhibit a high degree of platy and fibrous cleavage. A number of preparation techniques have been developed for reducing preferred orientation effects. These were tested, but none were found to give satisfactory reproducibility. Accordingly a technique was developed and employed which gives a high degree of sensitivity for substances present in minute quantities and with a greater level of reproducibility of reflection intensities.

Binary systems of three asbestos minerals in talc were prepared at varying levels of dilution concentrations. Standard weights of these mixtures were dispersed in water with ultrasonic energy to disperse the phases homogeneously. This slurry was filtered through a membrane filter by use of a hypodermic syringe (Fig. 1). The residue forms a flat cake which is mounted for x-ray analysis. This technique has the advantage of uniformly preparing, mounting and measuring the talc-asbestos dilutions under identical conditions.

Because of the structural similarities between some of the minerals, there was considerable overlapping or interference in many reflections, and this made it necessary to select reflections which could be unambiguously used as indices of the amount of each mineral present. These diagnostic reflections were step-scanned at $0.01°2\theta$, in a fixed-count mode. This permits the weak reflections produced at low dilution levels to be determined with precision. From the fixed-count data a profile of the diagnostic reflection is obtained and the area above background is taken to be proportional to the reflection intensity. The results of these analyses are given in Table 1, which shows that: chrysotile at dilution levels less than 0.25% was not detected, tremolite was detected down to 0.1% dilution level, and anthophyllite was not detected at concentrations below 2.0% (diagnostic reflection is at 8.26 Å; $I/I_1 = 55$).

In order to determine the number of chrysotile fibers present at various dilution levels, aliquots of the various dilutions were prepared for EM scanning. A fairly standard technique called the rubout method was used. For each dilution level, 20 fields from three EM grids are photographed at constant magnification and the number of long unit fibrils per field are counted from printed enlargements (Figs. 2 and 3). These fiber counts show fairly good correlation with levels of chrysotile dilution. By using the fiber count data, it is possible to calculate the number of fibers in a unit weight of sample. Thus, at a 1% dilution level there would be about 40×10^8 fibers/mg. Even at the lowest level of detection by x-ray diffraction, i.e., 0.25%, there would be about 10^9 fibers/mg. Cosmetic talcum powder, for example, which had been step-scanned and chrysotile not found might contain billions of fibers released during dusting with a half-gram dose.

Thus, very large numbers of asbestos fibers may be present in talc end products, yet they remain undetected if only optical microscopy and x-ray diffraction are used. On the other hand, EM can be a very sensitive method for detecting extremely minute amounts of asbestos in talc.

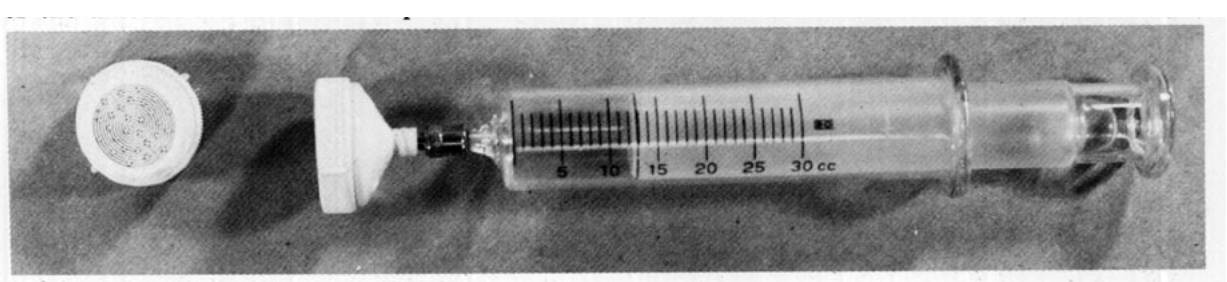

Table 1. Comparison of lower limits of detection of asbestos minerals in talc by step scanning and continuous scanning.

Asbestos mineral	Diagnostic reflection, Å	Detection limit concentration, %	
		Step scanning (0.01° 2θ) [a]	Continuous scanning (1° 2θ/min) [b]
Chrysotile	3.66	0.25	1.0
Tremolite	8.38	0.10	2.0
Anthophyllite	8.26	2.0	4.0

[a] Operating conditions: fixed count rate = 2000; 45 kV, 20 mA.
[b] Operating conditions: 500 counts/sec; time constant = 2.0; 45 kV, 20 mA.

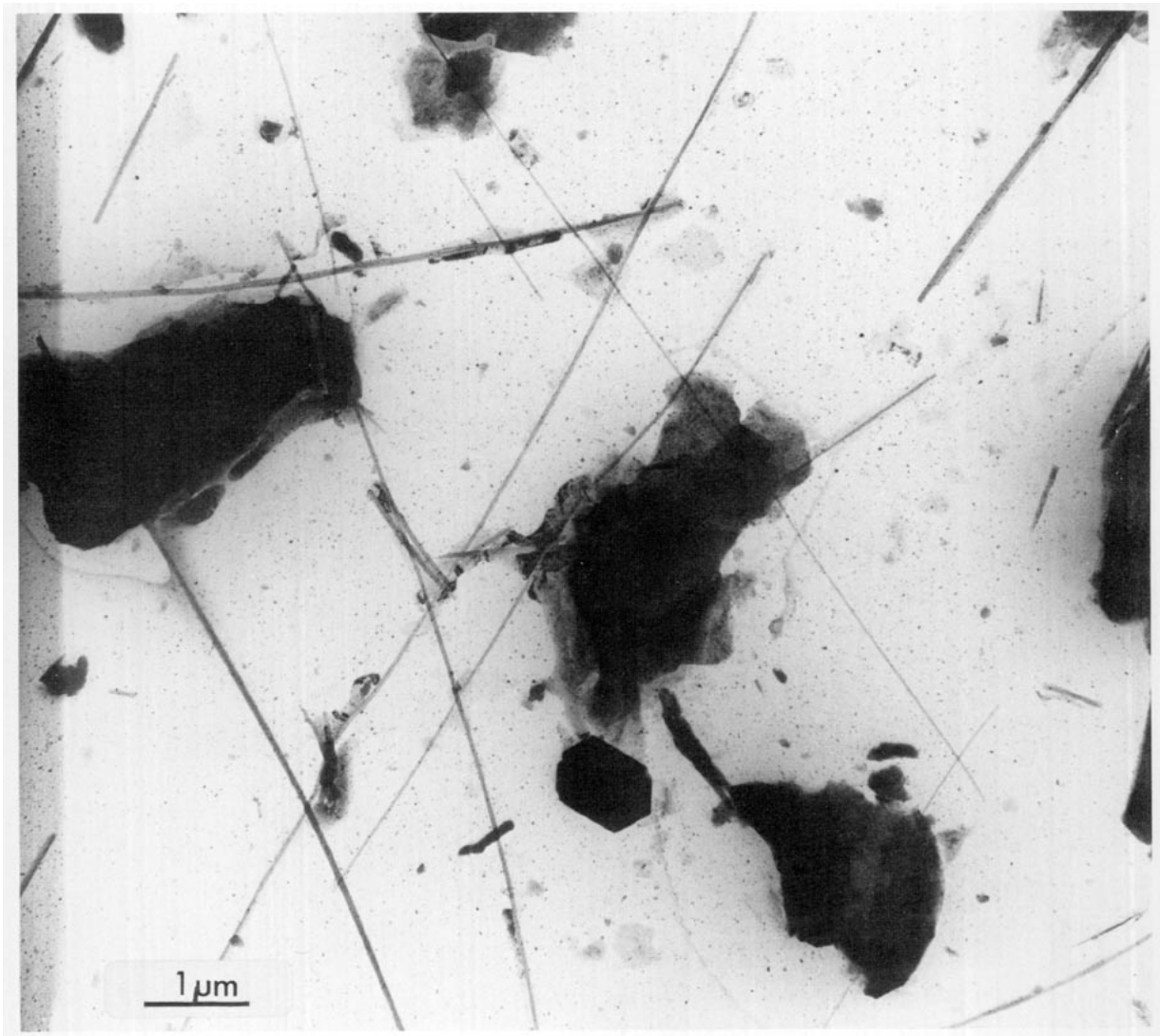

FIGURE 2. Electron photomicrograph of chrysotile–talc (99% talc, 1% chrysotile).

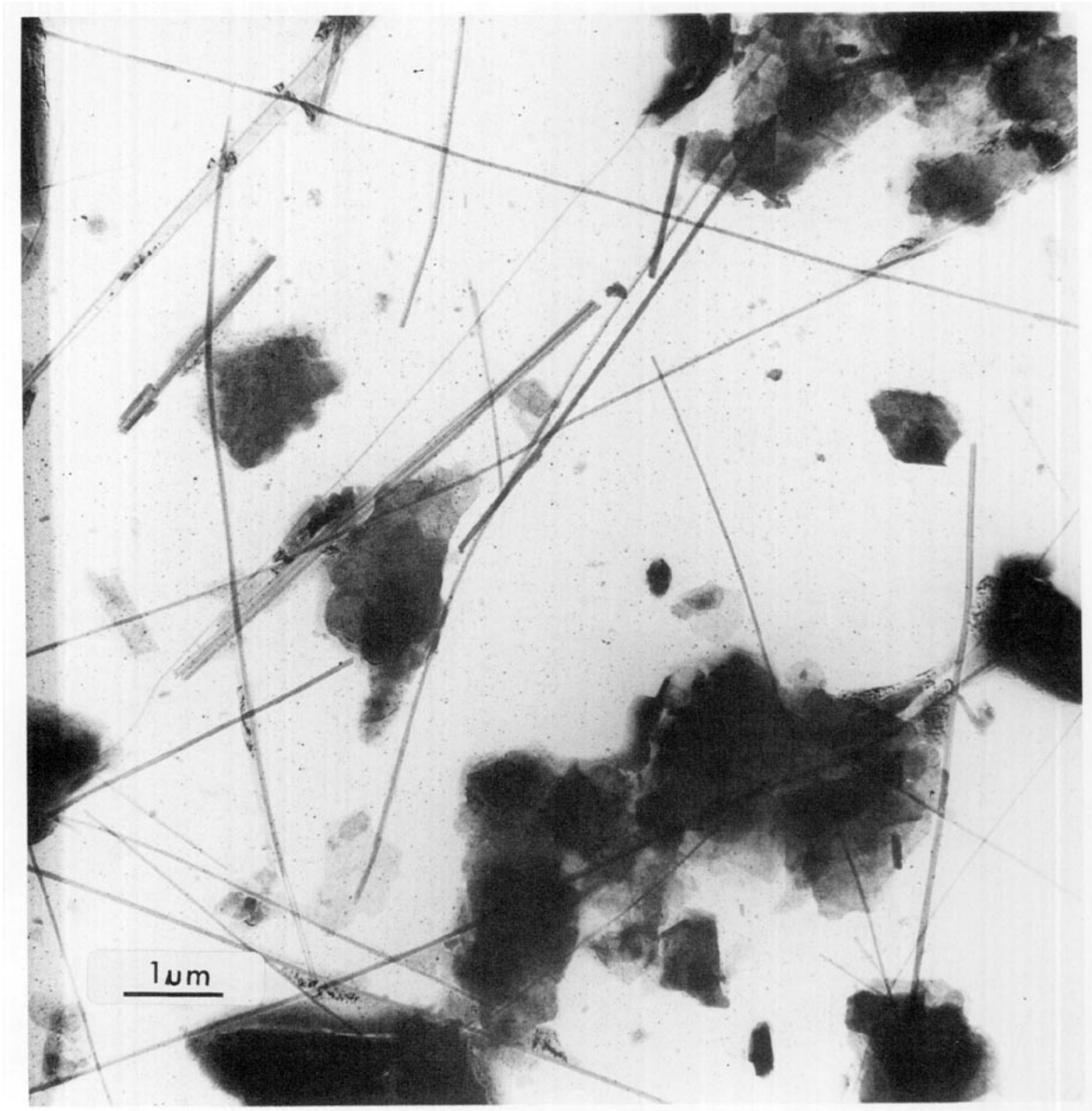

FIGURE 3. Electron photomicrograph of chrysotile–talc (95% talc, 5% chrysotile).